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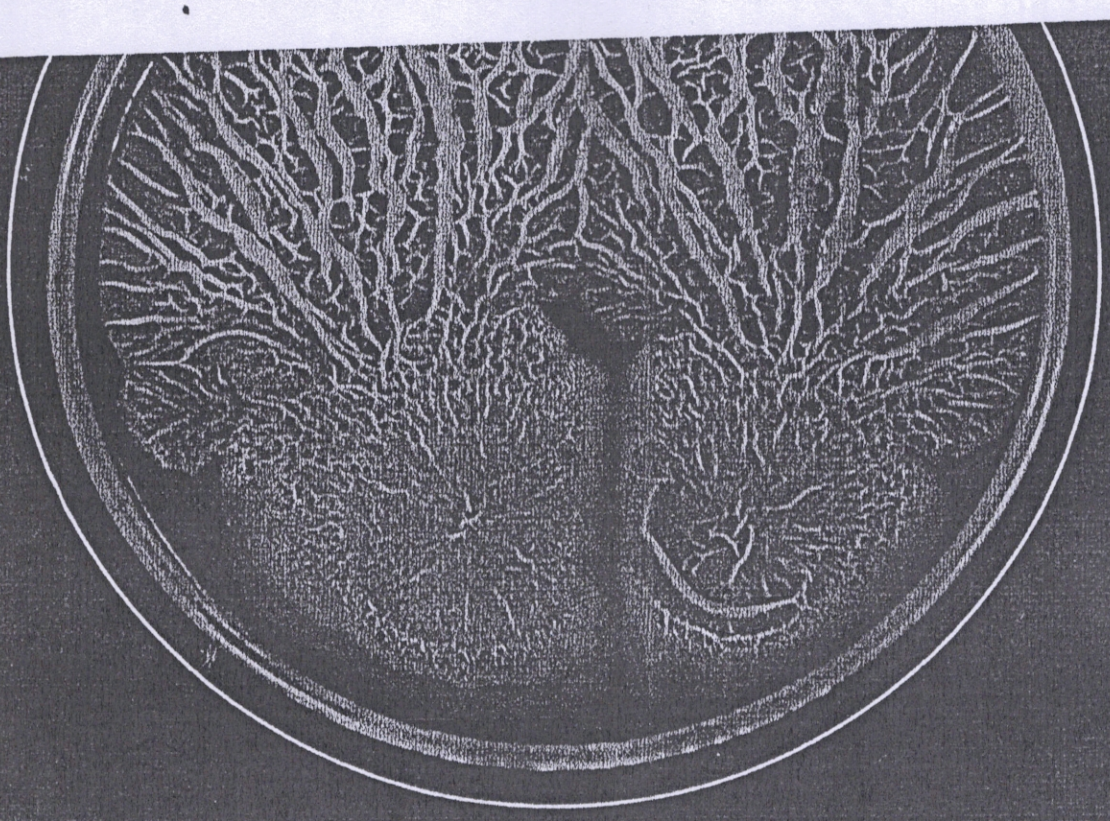
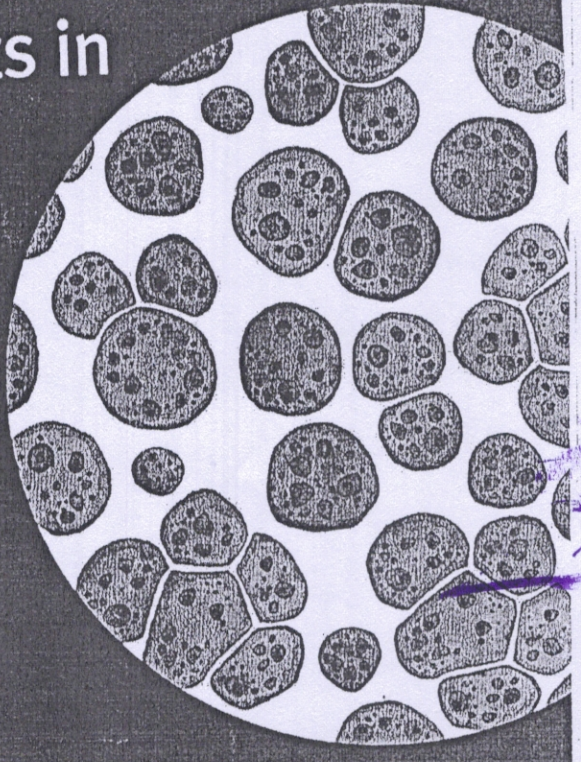
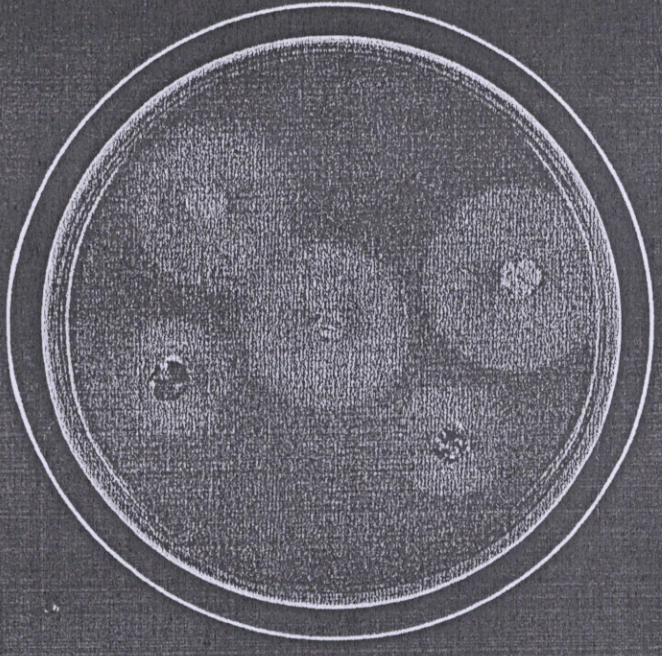


New and Future Developments in Microbial Biotechnology and Bioengineering

Sustainable Agriculture: Advances in Microbe-based Biostimulants





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Anukool Vaishnav

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New and Future Developments in Microbial Biotechnology and Bioengineering

Sustainable Agriculture: Microorganisms as Biostimulants

2022, Pages 45-62

CHAPTER 4 - Arbuscular mycorrhizae, a treasured symbiont to agriculture

Ajay Nair [a], Archana S. Rao [a], L. Bhanu [a], Veena S. More [b], K.S. Anantharaju [c], Sunil S. More [a]

https://doi.org/10.1016/B978-0-323-85163-3.00011-9

Abstract

Food accounts for one of the most basic necessities in human society and the food industry relies solely on agriculture. Agriculture depends almost entirely on chemical fertilizers and pesticides for its sustenance and productivity. But with this chemical over abuse, came a fair share of hazardous effects ranging from environmental pollution, bioaccumulation, biomagnification, to deleterious effects on indigenous microorganisms etc. And therefore, it was the need of the hour to find alternate, eco-friendly approaches such as botanicals, microorganisms and the derived products of biologicals etc., that would improve plant growth and yield. Vesicular Arbuscular Mycorrhizae (VAM) is one such beneficial microorganism, which helps in enhancing the agricultural production by benefitting the plants in many ways. They help plant by enhancing the growth and yield, also many bio stimulants which indirectly helps by protecting the crop from invading pathogens. Therefore, it is crucial that we explore ways in which VAM might prove useful in meeting the global demand for quality food, one which will be safe for human consumption, without any pesticidal residues, and also reduces the pollution caused by chemicals. The present chapter, hence, summarizes some of the well documented roles of VAM in enhancing the quality and quantity of production of agricultural commodities.

Key words

AFM; AM; VAM; Agriculture; PGPR; Biocontrol

New and Future Developments in Microbial Biotechnology and Bioengineering

Sustainable Agriculture: Advances in microbe-based biostimulants

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Extremophiles for sustainable agriculture

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11.1 Introduction

Agriculture was the prime occupation years back, and India was an agricultural country. However, owing to population growth, industrial advances and socio-economic changes, agriculture has been badly affected. Lack of cultivable lands to meet the growing demand for food continues to be a big problem. Therefore, measures ought to be taken to increase the agricultural production with the limited cultivable land available. Qualitative production of agricultural commodities is as important as quantitative production. There are many factors which negatively impact the production at both ends, which are as follows:Majorly, biotic factors like rodents, birds, insect pests and microbial pathogens reduce crop production. Microbial pathogens mainly including bacteria, fungi and virus are detrimental to crops causing many diseases in plants. However, there are another group of microorganisms, which have developed the mechanism of competing and mitigating these pathogens. Biocontrol agents are microorganisms that protect plants by inhibiting the growth of pathogens. Many microorganisms are a boon to agriculture where they promote plant growth, enhance the nutrition uptake, and increase the crop yield. These microbes are categorized as plant growth promoting microorganisms (PGPM). Therefore, as plant growth promoters or biocontrol agents, microbes are pivotal to agriculture.

Besides the aforesaid biological stresses, the crops growing in fields, also encounter abiotic stresses like temperature, pH, pressure, drought, exposure to toxic chemicals, salts, radiations etc., which are not optimal for their normal growth and reproduction. Most plants are inherently incapable of withstanding adversities,and this directly impacts agricultural production. Considering a country's economic status also tied to its agricultural prowess, research has been constantly trying to seek ways to improve agricultural practices. To achieve this, multiple tactics have been adopted as means for extenuating abiotic stressors to enhance the agricultural production: cultural practices, the genetic breeding, molecular approaches, chemical methods,

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Emerging Waste Management Techniques

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13

Biosorption of Heavy Metals and Metal-Complexed Dyes Under the Influence of Various Physicochemical Parameters

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13.1 Introduction

About three-fourth of the earth is occupied by water, the rich natural resource and vital for all forms of life on our planet. However, the rapid growth of industrialization over the years has led to the gradual depletion of this natural resource. Natural water bodies such as ponds, rivers, lakes, and seas have been highly affected by the discharge of industrial effluents. For instance, chemical processing and mining industries produce large amount of liquid effluents with heavy metals and toxic species. These pose serious ecological risks due to their nondegradable nature [1].

There are several industrial processes like mining, fertilizer production, surface finishing, electroplating, and electrical material production. Industries like mining and smelting of tanneries, atomic energy production, and aircraft production are the major sources of heavy metal pollution in aqueous systems [2]. But the excessive amount of toxic heavy metals are majorly discharged from power production from the steam, mining process with acid mine drainage, electrocoating process, and nuclear power production. In addition to that, textile, printing, petroleum, pesticide, solvent, and paint are major industries contaminating water bodies by organic-based chemicals.

In addition to that, industries such as plastic, fabric, and cosmetics produce a huge amount of synthetic colored products [3]. The dye production and raw material industries discharge 15% of untreated dye complexes along with the effluents into water bodies without any prior treatment. The discharged dyes comprised of different contaminants which are highly acidic or basic and dissolved or suspended. The untreated effluent leads to an increase in the hazardous effect in an aquatic

Biotechnology for Zero Waste: Emerging Waste Management Techniques, First Edition.
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Bioremediation of Pesticides Containing Soil and Water

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6.1 Introduction

Pesticides are defined as substances intended to kill, prevent, or regulate defined forms of plants or pests. They include weeds, rodents, insects, rodents, and fungi [1]. Some of the important types of pesticides used include herbicides, insecticides, fungicides, and disinfectants. They are used to destroy weeds, unwanted vegetation, growth of molds, mildew, and bacteria. Based on chemical nature, pesticides can be classified as organo chlorine pesticides, organo phosphorous pesticides, carbamates, neonicotinoids, and miscellaneous pesticides of biological origin like spinosad and abamectin [2].

Loss of pesticidal residues from one environmental compartment to another due to either degradation or transformation is defined as pesticide dissipation. The pesticide dissipation comprises various processes like adsorption, transformation, breakdown, and degradation. Releasing of pesticides into the environment can be either constructive or destructive as not the entire applied chemical reaches the target site [3]. Health effects of pesticides may either be acute such as headache, abdominal pain, nausea dizziness, and vomiting. Along with these, problems related to skin and eye also persists. Cancer, nerve illness, contrary effects on reproductive tract, chronic kidney diseases of unknown etiology, etc. are few to add to the list [4–9].

Insecticides like methyl parathion, dichloro-diphenyl-trichloroethane (DDT), and particularly pentachlorophenol will interfere with the chemical signaling between legume and rhizobium. This leads to reduced crop yields due to reduced nitrogen fixation. Root nodule development in these plants guards the world economy roughly US10 billion every year through artificial nitrogen fertilizer [10]. According to the

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Sanjay Sahay *Editor*

Extremophilic Fungi

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Biotechnological Application of Extremophilic Fungi

15

Aneesa Fasim, H. K. Manjushree, A. Prakruti, S. Rashmi, V. Sindhuja, Veena S. More, K. S. Anantharaju, and Sunil S. More

Abstract

White biotechnology (BT), a sustainable and eco-friendly technology, has taken precedence over chemical industries in the last few decades. It has revolutionized the industrial BT sector by exploiting abundant natural resources for the production of important commodities benefiting mankind. Industries employ microorganisms or biomolecules extracted from them for production and processing in various industrial areas such as food and feed, beverages, agriculture, pharmaceutical, textile, leather, paper, detergent, polymers, cosmetics, waste management, etc. Despite the advantages, the use of biomolecules is not substantial because they cannot tolerate harsh industrial conditions, which in turn affects the production process. In the last decade, the industrial research focus has shifted toward extremophiles, organisms that can survive extreme conditions. These organisms have evolved defense mechanisms to survive severe conditions such as high or low temperature, salinity, pressure, pH, radiation, and desiccation. Biomolecules extracted from these organisms have robust characteristics to retain optimum activity even under unnatural conditions. A class of eukaryotes called extremophilic fungi are at the crux of this research focus as they are a reservoir of sturdy biomolecules with many industrial applications. Fungal extremozymes can be easily cultured on agro-industrial waste and also easily purified. All these factors make fungal extremozymes an attractive resource for large-scale, cost-effective, and eco-friendly industrial processes. In addition to extremozymes, extremophilic fungi are an abundant resource of potent cytotoxic, antimicrobial

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Extremophilic Fungal Xylanases: Screening, Purification, Assay, and Applications

17

Aneesa Fasim, A. Prakruti, H. K. Manjushree, S. Akshay, K. Poornima, Veena S. More, and Sunil S. More

Abstract

Lignocellulosic biomass is an abundant natural resource that can be utilized for the production of commercial products beneficial to mankind. Biomass degradation and processing is the first step to harness its potential and this is achieved by hydrolase enzymes. Xylanases are one such enzyme that plays a vital role in the degradation of xylan, a major component of lignocellulose. During the last decade, demand for xylanases has markedly increased due to its wide applications not only in the biofuel industry but also in various other industries such as baking, beverage, degumming, paper and pulp, and animal feed. Xylanases are produced by many microorganisms but fungal xylanases are preferred due to their high enzyme production, ease of culturing on cheap agro-industrial substrates, and easy purification. The latest advancement in xylanase research is the discovery of extremophilic fungi (EF) xylanases that have robust characteristics and can retain activity even under harsh industrial conditions such as high or low pH, salt concentrations, pressure, and temperatures. These qualities can drastically benefit the global economics of biofuel production, paper and food industries, and many other industrial production processes.

Thus, a detailed review of several techniques of isolation, screening, and characterization of EF xylanases is discussed here. A comprehensive summary of purification and different assay techniques has also been listed to better understand and optimize enzyme extraction. Improved understanding of the biochemical properties of fungal xylanases allows the exploration of xylanases for various inventive industrial and biotechnological uses.

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Fungal Extremozymes in Green Chemistry

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Ajay Nair, Archana S. Rao, K. Nivetha, Prakruthi Acharya, Aneesa Fasim, Veena S. More, K. S. Anantharaju, and Sunil S. More

Abstract

An endeavor to accommodate sustainability within chemical manufacturing led to the recently popularized green chemistry. For a chemical process to be green, it must meet the following criteria: avoiding usage of non-biodegradable materials, all industrial processing transformations should lead to minimal waste accumulation, the processes must be cost-effective, both energetically and economically, etc. This is why biocatalysis using enzymes brought about a monumental shift toward a greener chemical process. Since its initial introduction, enzymes have mediated almost all industrial sectors, from pharmaceutics to food industry, pulp, textile, agro-waste management, bioremediation, etc. Recently, metagenomic approaches have led to the discovery of enzymes from extremophilic organisms that thrive under conditions considered optimal for most life on earth. Most of these extreme-loving organisms are bacterial or fungal in origin. Regardless of their origin, it has been demonstrated that extremozymes produced by them are far more efficient and resilient under the harsh industrial conditions. This makes them preferred candidates to be used as biocatalysts. Recently, several extremozymes of fungal origin have gained interest as potential industrial biotransformants. This chapter discusses the applications of fungal extremozymes, improves on the synthesis, bioconversions, and bioremediation processes.

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Molecular adaptations in proteins and enzymes produced by extremophilic microorganisms

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7.1 Introduction

Microorganisms are the ubiquitous living entities present on the planet. One such economically important but less explored category of microbes are the extremophiles. Extremophiles, have not only shown their ability to sustain but also thrive under extreme conditions on Earth. Some extremophiles simultaneously display capabilities to survive in multiple forms of stress and are known as polyextremophiles [1]. Their uncanny ability has drawn research interest from multiple disciplines, such as microbiology, geology, molecular biology, biotechnology, etc. Research in the recent past has primarily focused on understanding the molecular underpinnings that govern an extremophile's survivability [2,3]. Abiotic factors are central to life and its sustenance. Most life forms consequentially thrive within the physical boundaries or factors considered as optimal living conditions for them. These physical boundaries/factors have different impacts on the cell. The cell in turn has also evolved and responded accordingly. In the domain of life, extremophiles are the ones that can thrive in every possible extremes of temperature, pH, pressure, radiation, salinity, energy, and nutrient limitations available on Earth [4]. The adaptation strategies employed by extremophiles vary immensely [3]. Where most organisms have moved on towards a DNA-based, protein-centric world, most extremophiles continue to depend on secondary RNA structures for key cellular and molecular processes [5]. The varying nature of external conditions or stresses in extremophiles influence almost every cellular aspect including growth, nutrient assimilation and developmental processes [6]. The genome itself can get modified to

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Chapter 12
Role of Blockchain in Tackling and Boosting the Supply Chain Management Economy Post COVID-19

N. Kamalakshi and Naganna

12.1 Introduction

The novel coronavirus (COVID) belongs to coronavirus family of viruses (WHO/Europe). The transience rate of COVID-19 is a reduced amount rather than that of the severe acute respiratory syndrome (SARS) [1] and Middle East respiratory syndrome (MERS) coronavirus diseases. The coronavirus has created remarkable disorder globally disturbing human life and severely causing a huge number of deaths. It was first noticed in Wuhan, China, December 2019. By analyzing the severity of the epidemic for a larger scale, the World Health Organization (WHO) was obligated to announce it as a pandemic in a short span due to its large-scale spreading. Individuals infected with COVID-19 have had a wide range of symptoms reported, ranging from mild symptoms to severe illness. Patients infected with the disease may have symptoms from days 2 to 14 subsequently after the contact to the virus. The symptoms are depicted in Table 12.1 [2, 3, 22–48].

The global pandemic of novel coronavirus pneumonia affects the hearts of people across the world. Scientists worldwide are searching for a vaccine to counter the virus, which is spreading across the world. The *rapid* growth of COVID-19 has created numerous problems in the governments' state of being able to retort systems while projecting and showcasing an incompetence to gauge the solution as to the growth of the epidemic. Determining the root cause of an epidemic, quarantining the infected patients, managing serious patients, and avoiding cross infection between healthcare professional do entail tremendous manpower and an increased pandemic threat further leading to great challenges worldwide along with tracing

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Chapter 6
Role of Blockchain in Agriculture and Food Sector: A Summary

N. Kamalakshi and Naganna

6.1 Introduction

Agriculture is one of the most significant jobs not only in India but also everywhere in the entire world, for the most obvious reason – grow food and feed people. The concept of agricultural farming after the Stone Age has been evolving ever since the globalization and era of Internet of Things (IoT) and machine learning in post modern era, in spite of this, the humankind has not got rid of the agriculture sector. That shows the perennial nature of this profession. We as *Homo sapiens* have built our society on agriculture. Therefore, agriculture is the basis of a country's economy. And the farmer is the backbone of society. Agriculture has a major contribution and plays a significant role in the overall societal and economical foundation and steadiness. Progression and expansion in agriculture sector not only are crucial but also incur food security; it plays an important role in employment generation as well. However, growth of agriculture depends on various factors like investment which contributes the most. The issues and the challenges are ignorance and low priority in terms of public investment. Also, there is no proper guidance, security, and management maintenance training for farmers. Even though farmers work full days to get a good yield, they sleep without food, and every year, lakhs of farmers commit suicide due to nonpayment of loan, and in a day, more than lakhs of people are quitting agriculture profession due to loss, nonsecurity, and no turnover for his/her hard work and finally moving toward metropolitan cities in search of secure job with handful money. To address this issues and help the farmers with the emerging trend and technologies, the blockchain mechanism has been incorporated for agriculture [27–31].

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About the Book

IoT (Internet of Things) is an advanced automation and analytics system which exploits networking, sensing, big data, and artificial intelligence technology to deliver complete systems for a product or service. When applied to any industry or system, these solutions provide for increased transparency, control, and performance. System automation, analysis, and integration may all be improved using IoT technologies. They extend the range and increase the precision of these regions. Sensors, networks, and robots are all part of the Internet of Things.

IoT systems may be used in a wide range of businesses because of their capacity to adapt to any environment. Smart gadgets and powerful enabling technologies improve data collecting, automation, and operations, among other things.

The goal of this book is to provide you a comprehensive introduction to the Internet of Things. It explains the fundamentals of the Internet of Things, which are essential for implementing and exploring IoT systems.

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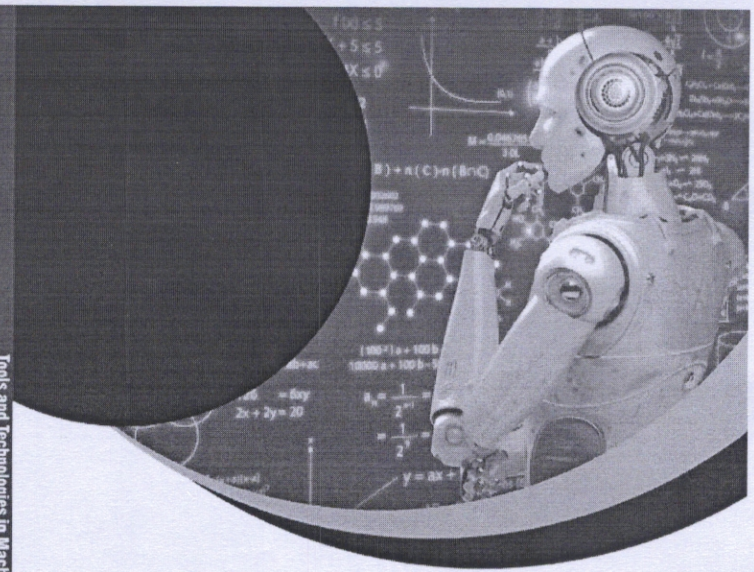

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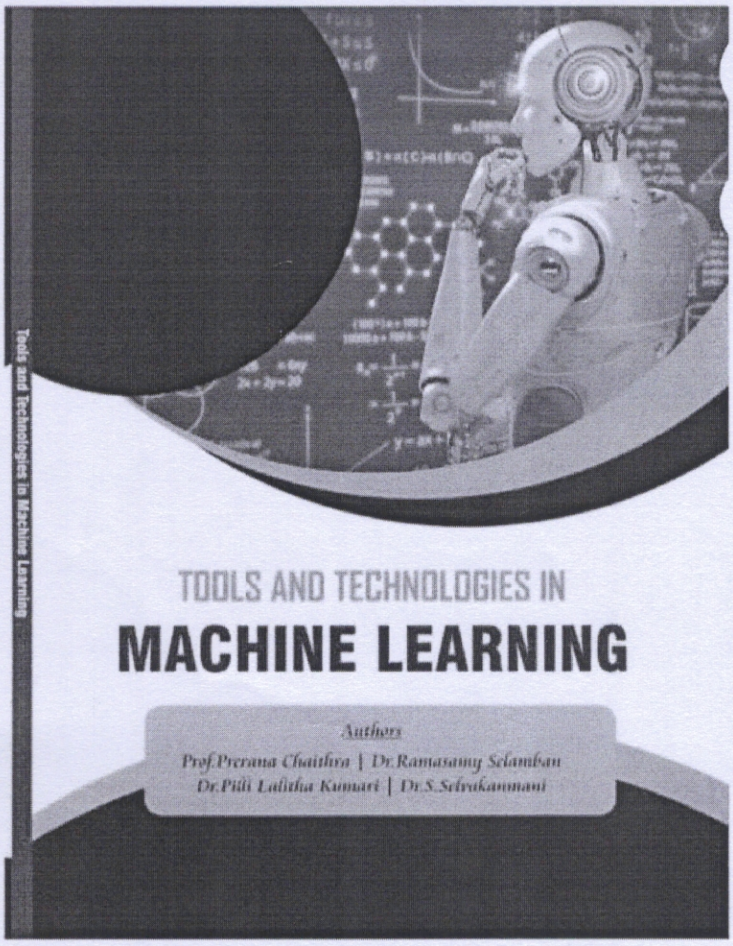

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